



***FINAL ENVIRONMENTAL IMPACT STATEMENT FOR  
THE OUTRIGGER TELESCOPES PROJECT***

***VOLUME I***

*Mauna Kea Science Reserve, Island of Hawai'i*

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Universe Division  
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and the public who identified the following important cumulative impact concerns associated with the Outrigger Telescopes Project: the Wēkiu bug and its habitat on Mauna Kea; the release of sewage system effluents into subsurface cinder at the summit; and, even more importantly, the central role of Mauna Kea in the cultural and spiritual life of Native Hawaiians.

NASA also determined that, in general, the time frame for the cumulative impact evaluation would extend from about 1964, before the first telescope was installed on Mauna Kea until the year 2033 when the lease agreement between the State of Hawai'i and the University of Hawai'i ends. NASA consulted with the community, local organizations, government agencies, and the existing observatories on Mauna Kea to identify projects and activities on or near Mauna Kea that could occur within the reasonably foreseeable future, *i.e.*, between the present and 2033.

Past activities considered in the cumulative impact analysis include all observatory construction and related activities.

Foreseeable future activities include both astronomy and non-astronomy-related projects and activities. Activities at the end of the lease agreement in 2033 have been addressed by considering two bounding possible outcomes.

**Cultural Resources.** Mauna Kea has a rich traditional history and many archaeological sites, including some that have yet to be discovered. Before 1982, only limited cultural and archaeological surveys were conducted in preparation for developments on the mountain. Thus, it is not known whether development beginning in 1964 has damaged subsurface cultural resources. However, such development has clearly altered the appearance of the Kūkahau'ula traditional cultural property, interfered with

views to and from the summit, and affected traditional cultural resources.

Because of these effects, NASA made a particular effort to consult with Native Hawaiian religious practitioners regarding the impacts of the Proposed Action as well as astronomy development in general on their religious practices. These practitioners described their belief that development on the summit is an invasion by ordinary man into the sacred realm. They find the domes and associated vehicular traffic to be destructive of the ambience of reverence necessary to their religious observances. They also find that the domes obscure their view of the stars necessary to achieve proper alignment. Further they believe that the alteration of the shapes of the *pu'u* associated with observatory development is both a desecration and an impediment to religious practices dependent on the alignment of physical features.

Grading and removal of earth for new structures, redeveloped structures, roads, and other astronomy projects could further affect these resources adversely. Following appropriate mitigation measures, such as those described in the NHPA Section 106 MOA, and developing project-specific mitigation measures for future activities would reduce adverse effects.

Mitigation measures developed for the Outrigger Telescopes Project and made part of the Section 106 MOA would minimize the impact of the Outrigger Telescopes Project and could potentially provide beneficial impacts, including community outreach and cultural stewardship.

From a cumulative perspective, the impact of past, present, and reasonably foreseeable future activities on cultural resources on Mauna Kea is substantial and adverse. The addition of the Outrigger Telescopes to the

existing observatories on the mountain would have a small incremental impact.

**Biological Resources and Threatened and Endangered Species.** There have been moderate to substantial impacts to biological resources, particularly the Wēkiu bug, a candidate species for listing under the Endangered Species Act. The impact of reasonably foreseeable future activities from all causes is likely small to moderate. From a cumulative perspective, the impact of past, present, and reasonably foreseeable future activities on biological resources on Mauna Kea is substantial and adverse. The addition of the Outrigger Telescopes would have a small incremental impact. Further, on balance, the impact from the Outrigger Telescopes Project is likely to be beneficial as a result of Wēkiu bug habitat restoration and the autecology study. Overall, the cumulative impact to biological resources is adverse and significant.

**Hydrology, Water Quality, and Wastewater.** The impact of past, present, and reasonably foreseeable future astronomy-related activities, including the Outrigger Telescopes Project, on the hydrologic system is negligible. Therefore, the cumulative impact on hydrology and water quality is not significant.

**Solid Waste and Hazardous Materials Management.** Impacts of solid waste on biological resources, water quality, and aesthetics from past, present, and reasonably foreseeable future activities are small, if any, transient, and not significant. The incremental impact of the Outrigger Telescopes Project would be small and not significant.

Impacts of hazardous materials on biological resources, water quality, and aesthetics from past, present, and reasonably foreseeable future activities are small and not significant. The incremental impact of the

Outrigger Telescopes Project would be small and not significant.

**Geology, Soils, and Slope Stability.** The impact of past and present activities on geology, soils, and slope stability has been substantial. The impact of foreseeable future activities is anticipated to be small. The Outrigger Telescopes would add a small and not significant incremental impact. The overall cumulative impact has been significant.

**Land Use and Existing Activities.** Most past, present, and reasonably foreseeable future activities on Mauna Kea are consistent with State and local plans and compatible with State land use designations. The Outrigger Telescopes Project would have no incremental impact on land use.

From a cumulative perspective, the impacts of past, present, and reasonably foreseeable future activities on other existing activities on Mauna Kea are substantial. The addition of the Outrigger Telescopes to the existing observatories on the mountain would have a small incremental impact.

**Transportation.** Past, present, and reasonably foreseeable future activities enable greater access for visitors and Native Hawaiians traveling to Mauna Kea. Greater access has led to a substantial increase in traffic volume along the Mauna Kea Access Road. This increase has resulted in a substantial impact on the natural setting of Mauna Kea.

The on-site construction and installation of the Outrigger Telescopes would result in a small, short-term increase in the current traffic volume. Operations of the Outrigger Telescopes would contribute only a small increase in current traffic levels. From a cumulative perspective, the impact of past, present, and reasonably foreseeable future activities on transportation on Mauna Kea is significant. The addition of the Outrigger

Telescopes to the existing observatories on the mountain would have a small incremental impact on transportation.

**Utilities and Services.** Past, present, and reasonably foreseeable future activities on Mauna Kea have led to the development of a water supply system, which constitutes a substantial impact on water supply. The water usage and traffic associated with water delivery are small and not significant in comparison to overall island water usage and Mauna Kea Access Road traffic levels. The addition of the Outrigger Telescopes to the existing observatories on the mountain would have almost no incremental impact on utilities and services.

Past and present activities on Mauna Kea have led to the development of electrical power and communications infrastructure, which constitutes a substantial impact on such capability. Reasonably foreseeable future activities are anticipated to have a small additional impact on electrical power and communications. The Outrigger Telescopes Project would have no incremental impact on the existing electrical distribution and communications systems.

Past and present activities on Mauna Kea have led to the development of emergency services and fire suppression capability. It is anticipated that foreseeable future activities would require similar additional development. The addition of the Outrigger Telescopes to the existing observatories on the mountain would have no incremental impact on emergency services and fire suppression capabilities.

**Socioeconomics.** The impact of past, present, and reasonably foreseeable future activities within the Astronomy Precinct on socioeconomics is substantially positive. The Outrigger Telescopes Project would add a small positive incremental impact. The

overall cumulative impact on socioeconomics is substantial and positive.

**Air Quality.** Past and present activities have had a minor continuing impact on air quality. Reasonably foreseeable future activities have similar impacts. The Outrigger Telescopes Project would employ mitigation measures and would have a very small incremental impact. Overall, the cumulative impacts to air quality are small.

**Noise.** The impact of noise from past, present, and reasonably foreseeable future activities is generally small. The Outrigger Telescopes Project would have almost no incremental impact. Although individual construction events would continue to produce occasional increased noise levels, overall noise conditions in the Region of Influence would remain low.

**Visual/Aesthetics.** The visual impacts of past and present astronomy-related activities in the MKSR have been substantial. Future visual impacts may be minimized by new design guidelines and careful site selection of new development projects. Mitigating dust generation, enforcing strict trash control, and minimizing on-site staging areas would reduce local short-term visual impacts. The Outrigger Telescopes Project would add a small incremental visual impact. Overall, the cumulative visual impact from past, present, and reasonably foreseeable future activities is substantial.

**Cumulative Impact Summary.** From a cumulative perspective, the impact of past, present, and reasonably foreseeable future activities on cultural and biological resources is substantial, adverse, and significant. The corresponding impact on socioeconomics is substantial and positive. In general, the Outrigger Telescopes Project would add a small incremental impact. Overall, past, present and reasonably foreseeable future activities have a

significant impact on the quality of the human environment.

### **ES.2.3 Description of the Canary Islands Site Alternative**

The Gran Telescopio de Canarias (GTC), a 10-m (33-ft) telescope modeled after the Keck Telescope, is currently under construction on the island of La Palma in Spain's Canary Islands, about 1,800-km (1,100-mi) southwest of Madrid, Spain. The GTC site is located within the Roque de Los Muchachos Observatory (ORM) near the northern end of the island.

The ORM is located at an elevation of approximately 2,400 m (7,900 ft) above mean sea level and occupies the north slope of a large volcanic caldera, the most prominent feature on La Palma. The 189-ha (467-ac) science site supports more than a dozen observatories. The GTC site may be characterized as a broad northwest sloping (18 percent) plain of altered volcanic material. A sizeable area adjacent to the GTC site has been disturbed by material staging and construction activities, but other adjacent area is undisturbed.

Locating the Outrigger Telescopes Project at the GTC site would involve the construction of four, and possibly up to six, 1.8-m (6-ft) Outrigger Telescopes together with their enclosures and domes, light pipes to transport the light from each telescope to a central beam combiner, and a separate structure to house the beam combiner facility. The GTC is being constructed with a coudé tunnel beneath the building which allows light from the 10-m (33-ft) telescope to be brought outside the observatory structure. This light path would feed directly into the beam combiner facility. The light pipes relaying light from the Outrigger Telescopes would also feed into the beam combiner facility, where a complex system of optics would combine

the light of the various telescopes together interferometrically.

### **ES.2.4 Environmental Impacts of the Canary Islands Site Alternative**

#### ***ES.2.4.1 Cultural Resources***

There are no groups that consider the ORM to be sacred or of religious importance, thus on-site construction and installation would have no impact on traditional cultural practices. Certain configurations of the Outrigger Telescopes could involve placing some of the Outrigger Telescopes in areas not previously surveyed for archaeological properties. For that configuration, additional archaeological surveys would be required. Based on prior experience, there is a reasonable likelihood that one or more additional archaeological sites would be discovered. However, suitable mitigation is likely to be possible.

Impacts to archaeological resources are likely to be small.

#### ***ES.2.4.2 Biological Resources and Threatened and Endangered Species***

A sizeable area adjacent to the GTC has been disturbed by material staging and construction activities. The relative impact of the Outrigger Telescopes Project would depend on the location of these telescopes in relation to the GTC. While it may be feasible to locate the Outrigger Telescopes wholly in previously disturbed areas, from a science and research perspective the optimal configuration would likely be similar to that on Mauna Kea (the Outrigger Telescopes placed in a configuration surrounding the GTC). Such a configuration would involve siting of some telescopes in previously undisturbed areas, leading to destruction of flora. Because of the nature of the site and flora involved, there would be difficulty in flora reestablishing itself. However, the